

THE ECOLOGICAL DISTRIBUTION OF THE
MAMMALS ON THE NORTH SLOPE OF
THE UINTA MOUNTAINS

A DISSERTATION SUBMITTED IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY IN
THE UNIVERSITY OF MICHIGAN

By
RUTH DOWELL SVIHLA

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THE ECOLOGICAL DISTRIBUTION OF THE MAMMALS ON THE NORTH SLOPE OF THE UINTA MOUNTAINS

INTRODUCTION

In ecology as in taxonomy, there is always a tendency to overdo classification—to attempt to reduce a subject, primarily plastic, to a system of pigeon-hole order. In the field of taxonomy the present tendency is to regard the whole system of classification as constantly evolving and developing in contrast to the older viewpoint of classification as a fixed and rigid system. Systematists are realizing that classification is merely the means to an end and must be kept as plastic as Nature herself. So with the study of an ecological subject, the schemes of classifying the data secured must be flexible to accommodate plastic material.

The community of interest of plant and animal ecologists is becoming more and more recognized. After all, plants and animals are both fundamentally protoplasm and while the details of their reactions and responses differ, the principles involved are the same. Plant ecology has advanced far beyond its sister field of animal ecology. It then behooves the animal ecologist to study well the methods and results of this related field in order to gain the advantages of its advances and to avoid its errors. Methods and concepts which have become more or less recognized in plant ecology should be scrutinized well as to their adaptability for animals. There is, perhaps, a human tendency to run to extremes—either to accept concepts with enthusiastic optimism or else to discard them entirely. It is to be hoped that in such a comparatively new field as animal ecology, a conservative course will be pursued, that methods and concepts will be tested critically and impartially before they are accepted or rejected and that where it becomes obviously necessary old ones will be modified or new ones evolved.

So far surprisingly little has been done in the way of actual field study of the ecological distribution of mammals as a group. Such workers as Grinnell and Swarth (1913), Shelford (1913), Grinnell (1914), Dice (1916), Grinnell and Storer (1924), Elton (1927), Merriam (1898) and his co-workers, and others have considered mammals in connection with the distributions of other vertebrates and invertebrates to varying extents. Aside from numerous annotated lists and descriptions of mammals and their habitats (Harper, 1929; Harper and Harper, 1929, and others) Adams (1908) is, perhaps, the only worker who has considered mammals by themselves to any extent in relation to ecological concepts.

In the present study, only the mammals were considered inasmuch as the distributions and ecological relationships of one group of animals are not necessarily the same as those of another. In an attempt to untangle the in-

terrelationships of animals and their environments, it seems most expedient to simplify a complicated matter as much as possible by considering the problems of one group of animals at a time.

The purpose of the present study has been fourfold: (1) to secure actual field data concerning the ecological distributions of the mammals on the north slope of the Uinta Mountains; (2) to classify these data flexibly according to different schemes of distributional classification; (3) to determine, by comparing the average indices of restriction for these different groupings, the most applicable scheme of classifying the distribution of the mammals of this region; and (4) to evaluate certain more or less accepted concepts according to the data secured.

The region chosen covers a comparatively small but diversified area. The inclusion of two topographic zones, four vegetation belts, various habitats and some 6000 feet of altitude made the study of both distributional and ecological problems possible.

Two summers (1928 and 1929) were spent in the field securing data. Notes and field observations on the habits, distributions and habitat relationships of the mammals were made. A total of 609 specimens were collected. The majority of these are now in the collections of the Division of Mammals, Museum of Zoology, University of Michigan. These represent 35 species and subspecies. The presence and distribution of eleven others were determined by means of tracks, pellets, authentic reports or personal observation. A large series of *Peromyscus maniculattus osgoodi* (263 specimens) was secured besides 33 live specimens which were sent to the Museum of Zoology, University of Michigan, as a breeding stock for variation studies carried on by Dr. L. R. Dice. An annotated list of the mammals of the Uinta Region, including the number of specimens taken and notes on their ecological distributions, has been published elsewhere.¹

Plants (74 species) which formed the dominant vegetation of the various zones, belts and habitats, were collected as well as species which were used as food by the mammals. These are preserved in the Herbarium of the University of Michigan. Identification of the plant material was made by Lois S. Ehlers, Dr. J. H. Ehlers, and Clair Brown. I am indebted to the Museum of Zoology of the University of Michigan for opportunity and facilities for carrying on this study; to Dr. L. R. Dice for constant help and advice throughout the work; to Prof. H. H. Bartlett who with characteristic generosity has given his valuable time and untiring patience; to Arthur Svihla for unflinching help in the field; and to the residents of the Uinta Mountain Region, who have proven the cordial hospitality of the West. The William P. Harris Jr. Research Fund has aided materially in helping to support the field work in this study.

¹ Jour. Mammal. 12: 256-266.

THE UINTA MOUNTAINS

LOCATION AND TOPOGRAPHY

The Uinta Mountains lie in the northeastern corner of Utah close to the Wyoming line and run in an east-west direction at practically the same latitude as Salt Lake City. They are a branch of the Wasatch Mountains (Powell, 1875) which lie at the west and extend in a north-south direction. These two ranges are at right angles to each other and are separated by the valleys of the Provo and Weber Rivers (Atwood, 1909), a distance of not more than ten miles (Fig. 1). The Uinta Mountains form an elongated, flat-topped arch (Boutwell, 1903) relieved by several high peaks. They are approximately 150 miles long and 35 miles wide. The main east-west divide lies north of the center of the range so that the northern slope is considerably steeper than the southern. The altitude of the range varies from 6500 feet to peaks more than 13,000 feet high (Boutwell, 1903).

The region considered in this study consists of a transect running from the sagebrush plains of the southwestern part of Sweetwater County, Wyoming and the adjacent portions of Daggett County, Utah, up the north slope of the Uinta Mountains somewhat east of the midpoint of the range (Figs. 2, 3). The mountainous part of the region lies within the boundaries of the Ashley National Forest. In altitude this transect ranges from 6000 feet, the valley of Henry's Fork, to 11,900 feet, the top of the peak known locally as the Nipple. This covers approximately thirty miles by road and trail or twenty miles in a straight line.

CLIMATE

Information concerning the climate of this region has been compiled from climatological data sheets and maps of the United States Weather Bureau (Day, 1920). The data (Table I) are those for Manila, Utah, which is the only station maintained in this region on the northern side of the mountains. Manila has an elevation of 6225 feet and is situated in the Lucerne Valley which lies in the sagebrush belt according to the classification used in this study. Hence, these data apply to a rather arid part of the region considered. Manila falls within the general range of 10 to 15 inches of mean annual precipitation. The belts of increasing amounts of precipitation up the mountain approximate in a general way the belts characterized by yellow and lodgepole pine (15 to 20 inches); spruce and fir, and alpine vegetation (more than 20 inches). On the southern slope of the mountains at an elevation of 5266 feet, lies Vernal, the climate of which is interesting by way of comparison. The precipitation data are different as would be expected. At Manila the greatest amount of rainfall occurs in the spring (April, 1.65 inches). The annual mean is 10.09 inches. At Vernal the greatest mean precipitation occurs in September with 1.2 inches and the annual mean is 8.67

inches. Although the mean annual temperatures of the two places are only slightly different (41.8° F. at Manila and 45.8° F. at Vernal), the frost data are such that the average length of the frostless season at Manila is 78 days while at Vernal it is 127 days. The effect of such a difference in length of growing season is seen in the fact that the Vernal region produces by far the greater amount of fruits and vegetables.

DISTRIBUTIONAL CLASSIFICATION OF THE MAMMALS OF THE UINTA REGION

TOPOGRAPHIC ZONES AND FAUNAE

The Uinta Region may be divided into two great topographic zones, the Plains Zone and the Mountain Slope Zone (Fig. 3). The Plains Zone includes the Sagebrush Vegetation Belt and is contingent with it. This zone is characterized by more or less rolling sagebrush plains subjected to relatively high summer temperatures, low winter temperatures and an annual rainfall averaging approximately 5 to 10 inches. In contrast to this, is the cool moist mountain slope extending from 8000 feet in altitude up to approximately 12,000 feet. This includes the three vegetation belts: Pine, Spruce and Fir, and Alpine.

Each of these two zones is distinguished by a number of characteristic species of mammals. However, there are in addition to these, 21 species which are common to the two zones, thus showing a distinct zonal overlapping. Fig. 3 shows that 13 species occur in the Plains Zone only, 21 species (including the bison) in both the Plains and Mountain Slope Zones, and 10 species in the Mountain Slope Zone only.

VEGETATION BELTS AND FAUNAE

This region falls naturally into four great belts of vegetation, namely: the Sagebrush; the Yellow Pine and Lodgepole Pine; the Spruce and Fir; and the Alpine (Figs. 2, 3). These belts are more or less sharply defined although there is considerable interdigitating and overlapping in places. This occurs especially in the mountain parks and along the streams and canyons. Between the Sagebrush and Pine Belts there is a minor cedar-pinyon area. This forms a fairly well marked belt on the southern slope of the mountains but is not extensive or as definite on the northern slope. It is confined to the arid slopes of the foothills, has no characteristic mammals and so is considered here as a minor belt. The vegetation belts range in altitude from 6000 feet, the sagebrush plains, to 12,000 feet, the top of the Nipple. The average annual rainfall increases with the altitude so that although 10 to 15 inches fall on the sagebrush plains, considerably more than 20 inches is the average annual precipitation on the mountain top (U. S. Weather Bureau, Chart I).

The mammal faunae of the vegetation belts are shown in Table III. The

Sagebrush Belt is the only one that has any significant number of characteristic mammals. Each of the other belts has but one species at most which is found only within its limits. However, grouping the three upper belts together, there are 10 species of mammals which occur only within their limits; compared with 13 which occur only in the Sagebrush Belt. There are, nevertheless, 21 species which are found in both the Sagebrush and upper belts. This lack of zonation in the distribution of the mammals is discussed later (p. 65).

SAGEBRUSH BELT AND FAUNA

Sagebrush, *Artemisia tridentata* Nutt., is the dominant plant over the broad general area which extends from the plains region of southwestern Sweetwater County, Wyoming, across the Lucerne Valley of northeastern Daggett County, Utah, to the foothills of the Uinta Mountains (Fig. 4). This belt ranges from 6000 feet to approximately 8000 feet in altitude and coincides practically with the region which has 10 to 15 inches of average annual rainfall. The upper portions of this belt include the cedar-pinyon area which occupies the more exposed parts of the foothills and the rocky slopes. Sagebrush forms the undergrowth of the sparse and scattered stands of cedars, *Juniperus utahensis* Engelm., and pinyons, *Pinus edulis* Engelm., and extends up to 9000 feet into the Pine Belt where it is restricted to the mountain parks (Fig. 9). Such an extension of a typical plains belt up into the forest belt carries with it characteristic habitats so that often a mixture of mammal species results. The Sagebrush Belt includes the following habitats: Sagebrush, which is the dominant habitat; Rock Cliff; and Streamside.

The total mammal fauna of this belt (Table III) includes 32 species. Thirteen of these are found only in this belt. The remainder are ranging forms which occur also in the upper belts.

BELT AND FAUNA OF YELLOW PINE AND LODGEPOLE PINE

The Pine Belt ranges from approximately 8000 feet in altitude to 10,500 feet and has an average annual rainfall of 15 to 20 inches. Here on the northern slope, yellow pine, *Pinus ponderosa* Dougl., and lodgepole pine, *Pinus murrayana* Balf., intermingle to form one general belt of vegetation in which yellow pine is more in evidence at the lower altitudes. The lodgepole pine supersedes the yellow pine over burned areas and in places occurs up into the spruce-fir forest. It forms such dense stands (Fig. 9) that practically no undergrowth can survive the subdued light conditions. This is in direct contrast to the open yellow pine forest (Fig. 13) which supports an extensive undergrowth of sagebrush, grasses and flowering plants. Mountain parks are relatively abundant in this belt. They consist of sagebrush interspersed with grasses. Along the canyons (Fig. 8), Douglas firs, *Pseudotsuga mucronata* (Raf.) Sudw., and aspens, *Populus aurea* Tides., occur

and often reach down into the Sagebrush Belt, thus extending the ranges of some of the forest mammals into an otherwise plains belt. Aspens also occur along the edges of the parks, where moisture conditions are favorable. This belt includes the following habitats: Forest, which is the dominant habitat; Rock Slide; and Streamside.

Of the 28 species of mammals which range into or through this belt, only one (*Zapus princeps princeps*; Table III) is restricted to it.

SPRUCE-FIR BELT AND FAUNA

This is relatively a narrow belt on the northern mountain slope extending (Fig. 15) from approximately 10,500 feet in altitude to timberline at 11,700 feet. Engelmann spruce, *Picea engelmanni* Parry, is the dominant tree and the subalpine fir, *Abies lasiocarpa* (Hook.) Nutt., is subdominant. Occasionally one also finds a Colorado spruce, *Picea pungens* Engelm. As a whole, this belt is open and supports an undergrowth of herbaceous plants, chief among which is the grouse whortleberry, *Vaccinium scoparium* Leiberg. Occasionally there are small boggy areas supporting a growth of sedges. The rainfall in this belt averages over 20 inches per year but the growing season is considerably shorter than that of the lower belts. The following habitats are recognizable: Forest, which is dominant; Rock Slide; and Streamside.

Twenty-three species of mammals are found in this belt, but only one, *Clethrionomys gapperi galei* (Table III), is restricted to it.

ALPINE BELT AND FAUNA

The Alpine Belt includes timberline and above. Hence, in the Uinta Region, it ranges from 11,700 feet to approximately 12,000 feet in altitude. Except for the very narrow line of krumholz and interspersed mountain meadows, it is nothing but a huge rock slide made up of pre-Cambrian red sandstone (Fig. 16). The krumholz consists of dwarfed and stunted Engelmann spruce and scattered patches of alpine willow, *Salix wolffi* Bebb. The meadows support a rich although dwarfed flora of grasses and flowering plants. Rainfall here is more than 20 inches per annum but on account of the steepness of the slopes and shallowness of the soil, most of it runs off and so is but slightly available to plant life. The growing season is less than two months in length and frosts may occur at any time during the summer. The habitats are Rock Slide, which is dominant, and Alpine Vegetation.

Of the 10 species of mammals which range through this belt, only one, *Thomomys*, sp. (Table III), can be considered peculiar to it.

HABITATS AND COMMUNITIES²

The following types of habitats are recognizable in the Uinta Region: Sagebrush; Streamside; Rock Cliff; Rock Slide; Forest; and Alpine Vegeta-

² For the senses in which these terms are used see p. 64.

tion. Some of these habitats are confined to one vegetation belt, as, for example, the Rock Cliff and the Alpine Vegetation Habitats. Others may occur in several belts, as, for instance, the Streamside, Sagebrush, and Forest Habitats. Each habitat shelters a community of mammals which may vary as the habitat becomes modified but as the term is used in this paper (p. 64), must contain one or more species peculiar to it in order to be significant in determining mammal distribution in the region. Many of these habitats may be subdivided into subhabitats or unit habitats but this has been done only when a mammal is obviously restricted to a certain modified area within a habitat. Table III shows the habitat-types and their respective mammal communities.

SAGEBRUSH HABITAT AND COMMUNITY

The Sagebrush Habitat shelters the Sagebrush Community of mammals and forms by far the greater part of the Sagebrush Belt in which it is the dominant habitat (Fig. 4). With the exclusion of the Streamside and Rock Cliff Habitats of the Sagebrush Belt, this habitat covers the rest of the belt. It extends up through the minor belt of cedar-pinyons into the Pine Belt where it forms the greater part of the mountain parks. Sagebrush, *Artemisia tridentata* Nutt., is the dominant plant of this habitat. On the plains north of Henry's Fork local areas of mat saltbush, *Atriplex corrugata* Ryd.; gray molly, *Kochia vestita* (S. Wats.) Ryd.; and two species of cacti occur. In some places there are areas of very sandy soil which are designated as subhabitats of the kangaroo rats, *Dipodomys* sp., for it is only here that they are found. Greasewood, *Sarcobatus vermiculatus* (Hook.) Torr., and rabbit brush, *Chrysothamnus graveolens* (Nutt.) Greene, are local in range along the banks of old stream beds. On the slopes of the foothills in the cedar-pinyon area and in the mountain parks of the Pine Belt, the Sagebrush Habitat becomes subdominant. Here, June grass, *Koeleria cristata* (L.) Pers., grows interspersed with the sagebrush. This grass is very luxuriant in early summer and provides one of the best forage plants for livestock grazing. The deer mouse and the jack rabbit extend their ranges up into the mountain parks of the Pine Belt along with the sagebrush. Above approximately 9000 feet in altitude, sagebrush gives way to shrubby cinquefoil, *Potentilla fruticosa* L., in the few mountain parks which occur above this altitude. The deer mouse was not found to occur any higher up the mountain side than where the sagebrush occurred.

Of the 18 species of mammals which were found in this habitat (Table III), 6 are restricted to it.

ROCK CLIFF HABITAT AND COMMUNITY

In contrast to the Rock Slide Habitat of the upper belts, which is made up of large blocks of pre-Cambrian sandstone, the Rock Cliff Habitat is found only in the Sagebrush Belt. It is formed from the up-tilted beds of

rocks ranging from Pennsylvanian to Cretaceous in age (Atwood, 1909). Such Rock Cliff Habitats are found just north of Henry's Fork, along Sheep Creek and at Hide Out on Green River. Where the cliffs are high talus slopes are formed at the bases. Cedars, *Juniperus utahensis* (Engelm.) Lemmon, and two species of cacti have become established on many of these slopes (Fig. 7).

The Rock Cliff Habitat shelters a community of mammals, three of which are peculiar to it (Table III). These species, *Peromyscus crinitus auripectus*, *Peromyscus boylei rowleyi*, and *Eutamias dorsalis utahensis*, are all characteristic of the southwestern desert region. The records for the two subspecies of *Peromyscus* are extensions of their known ranges.

STREAMSIDE HABITAT AND COMMUNITY

The Streamside Habitat includes the stream, its banks and adjacent areas which are conspicuously influenced by it. This habitat occurs in the Sagebrush, Pine and Spruce-Fir Belts. The streams in this region usually have their origin in the glacial lakes of the cirque-like basins just below timberline in the Spruce-Fir Belt. They flow with great rapidity down the steep slopes of this belt. In the Pine Belt, which spreads away at a gentler angle, their speed is accordingly reduced. Here they flow through the sagebrush parks and supply the adjacent vegetation with an abundance of water. In places thick stands of willow, *Salix geyeriana* Anderss., which form the willow subhabitat of the jumping mouse, *Zapus princeps princeps*, occur along the banks (Fig. 12). Quite distinct from the sagebrush which makes up the greater part of the parks, is the narrow strip of grass which lines the streams (Fig. 10). This is called the grassy flood plain subhabitat of the pocket gopher, *Thomomys pygmaeus*.

Streams often form canyons down the mountain side and thus extend the flora and fauna of the upper belts into the lower ones. Sheep Creek illustrates this (Figs. 6 and 8). According to the altitude and the adjacent dominant vegetation, this habitat is in the Sagebrush belt, but the presence of upper belt plants and mammals here show that these species have followed the cool streamside from the upper belt down into the Sagebrush Belt. This overlapping of belts results in a mixture where species which are characteristic of the Forest, Streamside, and Sagebrush Habitats intermingle. Douglas fir, *Pseudotsuga mucronata* (Raf.) Sudw., aspen, *Populus aurea* Tides., columbine, *Aquilegia caerulea* James, and Rocky Mountain bee plant, *Cleome serrulata angustata* (Jones) Tides., occur here with such sagebrush species as sagebrush, *Artemisia tridentata* Nutt., and rabbit brush, *Chrysothamnus graveolens* (Nutt.) Greene, and *Chrysothamnus linifolius* Greene; and such streamside species as cottonwood, *Populus angustifolia* James, water birch, *Betula fontinalis* Sarg., and willow, *Salix lasiandra* Benth. The pine squirrel, *Sciurus fremonti fremonti*, and the porcupine, *Erethizon epixanthum epix-*

anthum, range from the Forest Habitat of the upper belts down along this creek. The pocket gopher, *Thomomys pygmaeus*; shrew, *Sorex palustris navigator*; and chipmunk, *Eutamias minimus consobrinus*, are also upper belt species and were found in the Sagebrush Belt only along Sheep Creek.

Sheep Creek is an intergradation area for the *minimus* series of chipmunks. *Eutamias minimus consobrinus* at this locality approaches *Eutamias minimum minimus* in such characters as ear length and color. Typical *consobrinus* is found up the mountain slopes while at Green River City, Wyoming, which is well in the Sagebrush Belt, typical *minimus* occurs. At Henry's Fork, which is in the Sagebrush Belt but also in the foothill region, *minimus* approaches *consobrinus* in ear length and color characters. Thus, there is a gradation from typical *minimus* of the Sagebrush Belt to *minimus* approaching *consobrinus* and *consobrinus* approaching *minimus* in the foothill region to typical *consobrinus* on the mountain slope.

Of the 27 species of mammals found in the Streamside Habitat (Table III), 15 are restricted to it.

ROCK SLIDE HABITAT AND COMMUNITY

The Rock Slide Habitat consists of huge blocks of red sandstone which form slides in the Pine (Fig. 14), Spruce-Fir and Alpine belts. In the latter belt, it is the dominant habitat (Fig. 16). It remains unchanged throughout these belts and shelters a community of 7 mammals. Two of these, the deer-mouse, *Peromyscus maniculatus osgoodi*, and the golden-mantled ground squirrel, *Callospermophilus lateralis lateralis*, are not found further up the mountain than the Pine Belt; one, the wood rat, *Neotoma cinerea orolestes*, no further than the Spruce-Fir Belt; while the other four, the pika, *Ochotona princeps uinta*, hoary marmot, *Marmota flaviventris nosophora*, and two chipmunks, *Eutamias umbrinus* and *Eutamias minimus consobrinus*, extend up into the Alpine Belt (Table III).

FOREST HABITAT

The Forest Habitat consists of the forest areas of the Pine and Spruce-Fir Belts and so becomes the dominant habitat of these belts. In the Pine Belt, this habitat includes dense stands of lodgepole pine and the open growth of yellow pine (Figs. 9, 13). Aspens, Douglas firs, and other moisture requiring trees occur especially along the streams. These often extend down into the Sagebrush Belt and help to form the mixed habitats described on page 56. The yellow pine area supports an undergrowth of sagebrush and such herbaceous plants as bitterroot, *Lewisia rediviva* Pursh.; mountain death camas, *Zyadenus elegans* Pursh.; alum root, *Heuchera parvifolia* Nutt.; stone crop, *Sedum stenopetalum* Pursh.; columbine, *Aquilegia caerulea* James; paint brush, *Castilleja* sp.; sego lily, *Calochortus nuttallii* Torr. and Gray; larkspur, *Delphinium geyeri* Greene; etc. In the upper

parts of the Pine Belt, mountain juniper, *Juniperus sibirica* Burgsd., and bearberry, *Arctostaphylos uva-ursi* (L.) Spreng., occur. In the Spruce-Fir Belt (Fig. 15), besides the characteristic trees which are found here, there is a thick ground cover of grouse whortleberry, *Vaccinium scoparium* Leiberger. This habitat provides both food and shelter for the pine squirrel, *Sciurus fremonti fremonti*, the flying squirrel, *Glaucomys sabrinus bangsi*, and the porcupine, *Erethizon epixanthum epixanthum*, which are the characteristic mammals (Table III).

ALPINE VEGETATION HABITAT

This includes timberline krumholz and alpine meadow. The krumholz is made up of dwarfed Engelmann spruce, *Picea engelmanni* Parry and dwarfed willow, *Salix wolffii* Bebb. The alpine meadows are areas of varying sizes which are interspersed between extensive rock slides and the narrow line of krumholz (Fig. 16). The vegetation is low but very luxuriant during the short growing season. It consists of such plants as saxifrage, *Saxifraga* sp.; daisy, *Erigeron uniflorus* L.; pygmy bitterroot, *Lewisia pygmaea* (Gray) Robins; catch-fly, *Selene acaulis* L.; paint brush, *Castilleja* sp.; wood betony, *Pedicularis parryi* Gray; clover, *Trifolium parryi* Gray; knotwood, *Polygonum bistortoides linearifolium* (Wats.) Small; geum, *Sieversia turbinata* (Ryd.) Greene; and the thistle, *Carduus lanceolatus* L. The last two plants are used by the pikas, *Ochotona princeps uinta* (Fig. 17), for food and are stored away in piles during the summer. Deer, *Odocoileus hemionus hemionus*; elk, *Cervus canadensis canadensis*; and formerly bison, *Bison bison bison*, range up into this habitat for summer forage. Chipmunks, *Eutamias umbrinus* and *Eutamias minimus consobrinus*, occur here, as well as hoary marmots, *Marmota flaviventris nosophora*, and pikas, *Ochotona princeps uinta* (Table III). The Uinta pocket gopher, *Thomomys uinta*, is restricted to those meadows where the soil is deep enough to be workable.

SCHEMES FOR CONSIDERING DISTRIBUTION

THOSE IN COMMON USE

The various systems for classifying animal distributions have been discussed by Dice (1916). There are the zoogeographical, the life-zone, and the ecological systems. The life-zone system, exemplified by the life zones of Merriam (1898) and used by him and his co-workers, is based presumably upon temperature as the controlling factor. His life zones may be divided secondarily into faunal areas according to differences in humidity. The ecological viewpoint stresses the relationships which exist between animals and their more immediate environments. Animals are grouped according to similar habitats, communities or associations, all of which refer to the more immediate environmental conditions than do life zones. Shelford and his co-

workers have emphasized this point of view. Shelford (1913) included all animals, both invertebrate and vertebrate, into a classification of community-types based upon similarity of ecological behavior.

There has been a tendency to combine and modify these two viewpoints. Grinnell (1914) discussed both the zonal and the ecological or associational systems. He found that in California there were "three distinct orders of distributional behavior"—zonal, based upon temperature; faunal, based upon humidity; and associational, based upon environmental conditions. He classified the birds and mammals of the region into these three categories. Grinnell and Swarth (1913) used a similar classification. Dice (1916) found that the life zones of Merriam could not be applied consistently to the distributions of the land vertebrates of southeastern Washington. He classified the land vertebrates of this region as occurring in habitats which were grouped into faunal areas indicated by the dominant vegetation. Taylor (1922) grouped the birds, mammals and plants of Mt. Rainier, Washington, into life zones limited by temperature, and habitats with their associations which were based upon water relations. All these schemes are based presumably upon different combinations of the factors, temperature, humidity, vegetation and habitat.

NEED FOR A FLEXIBLE BASIS IN CLASSIFYING DISTRIBUTIONS

The main points in dispute in these classification schemes are the relative importance of the factors involved and their application to different groups of animals. It is only to be expected that different factors will be of different importance for different animals and animal groups. For instance, the kangaroo rat is limited primarily in its distribution by the nature of the soil, whereas the pine squirrel is found only where coniferous trees provide suitable food and shelter. In general, some insects are limited particularly by vegetation while land barriers limit the distributions of fishes. The determining factors will also differ markedly in different regions. Life zones, based upon temperature, may be definite and clear-cut with characteristic species, say, on San Francisco Mountain, but these same life zones with their indicators may not be recognizable or even present in southeastern Washington. Criticisms of the limitations of the life-zone system have been made by Trotter (1912), Shreve (1914), Dice (1916), Ruthven (1920), and others.

The chief difficulty in the application of the life-zone system appears to lie in the fact that temperature, the factor upon which it is presumably based, is not necessarily the critical factor in every region, and hence, this system cannot be applied indiscriminately. It is generally conceded that the distributions of animals, and indeed plants also, are determined rather by a complex of interacting factors than by one factor alone, although one factor may nevertheless be of more immediate influence than the others.

Would it not be far more satisfactory to have a completely flexible basis for classifying animal distributions so as to allow the recognition of the predominant importance in each region of the factor or factors which there, more than any other factor or factors, determine distribution? Thus, in a region where temperature is obviously the predominating factor, temperature zones could be indicated. Where humidity is dominant or where the vegetation or physiography is the conspicuous influence, humidity, vegetation or physiographic zones, belts or areas could be designated. Furthermore, a region may not be divisible into zones or larger divisions based upon the dominance of any one of these factors, but nevertheless might be classified according to habitats or associations which themselves represent organic response to a complex of environmental factors in which no single one necessarily controls. When all of these factors are influential and their effects of such a nature as to be separately discriminated, they all could be used in the order of their relative importance. If, as may very well happen in some regions, all the factors seem to be of equal importance, this should be admitted by the simultaneous recognition of more than one scheme of classification for a single region. One scheme may even be preferred arbitrarily to the others in order to emphasize or illustrate a certain point of view or method of attack. Such terms as zones, belts, areas, habitats and communities which are general and ordinarily used in an unrestricted sense, appear to be far more desirable than such terms as life zones, faunal areas and associations, because these latter terms have come to possess almost as many meanings as there are authors who have used them. General terms are easily modified by adjectives to fit the region under consideration.

The combinations of zonal and ecological methods of classification as used and modified by Grinnell, Grinnell and Swarth, Dice, Taylor and others have approached such a flexible system as proposed here. In their classifications, these authors have recognized the fact that the distributions of animals over a region may be controlled by their relationships to more than one factor by using more than one scheme of classification. For instance, Grinnell (1914) used three schemes of classifying the birds and mammals of California, thus recognizing the influence of three conspicuous factors. In this way he established a relatively flexible basis for classification.

Nichols (1929, pp. 629-641), in discussing the classification of plant associations, has pointed out three totally different viewpoints: (1) inherent composition and structure; (2) geographical relationships; and (3) succession. These have been used by plant ecologists in the interpretation of ecological relationships. "Any one of them, by itself, may be taken as a rational basis for ecological classification." He brings out the fact that in attempting to classify the facts of nature, no automatic or precise system can be devised. Differences in interpretation are inevitable and the "best that any scheme . . .

can hope to do is to furnish a sound framework, based upon generalized facts and fundamental principles." This very sane viewpoint may well be applied to the various schemes of classifying animal distributions.

Cooper (1926, p. 396) has recognized the necessity of classification as a foundation for understanding the various phenomena of plant ecology, but has emphatically warned against the use of a rigid, pigeon-hole system in which to cram the "fluent" processes of nature. Again (p. 412) he urges "fluency in the treatment of fluent material" and the "abandonment of concepts and terms which clearly tend toward rigidity."

AN INDEX OF RESTRICTION

In this study, only one group of animals, the mammals, is considered. The reason for this is obvious. The distribution of one group of animals over a region is not necessarily the same as that of another group over the same region. Hence, a classification is not necessarily applicable to more than one group. For instance, what may be a unit habitat for a number of mammals may include a dozen or more types of habitats or their equivalents for insects. The forest type of habitat for mammals considered in the Uinta Region, if applied to insects, would, no doubt, be subdivided into areas including different species of trees, each of which would be further divided according to strata. The streamside type of habitat, as it is considered in this region, shelters one definite type of mammal community, but if the bird distributions were considered, it would become necessary to divide it into several habitats including open water, shoreline, and brushwood.

A flexible system of classification, such as is described, is used in this paper. The aim has been to classify the mammals of the region in the most natural way possible according to what appear to be the conspicuous factors in their distributions. From data secured in the field, the mammals were grouped according to habitat-types, vegetation belts and topographic zones, for as viewed in the field, these were obviously the natural groupings. It was found that by comparing the proportion of restricted species to that of wide ranging species for these different classifications, that an index of the relative degree of restriction is obtained. By comparing the averages of these indices, the relative degree of restriction of the different groupings is revealed—the higher averages of course showing the greatest evidence of mammal restriction. It was found that the immediate environmental conditions or the habitat show the greatest degree of restriction and so form the most logical basis for classifying the mammal distributions in this region.

The relative degree of habitat restriction of mammal communities may be expressed by the proportion of restricted species to that of wide ranging species. This is illustrated by the following tabulation:

<i>Type of habitat</i>	<i>Restricted species (R)</i>	<i>Wide ranging species (R')</i>	<i>Index of restriction</i> $\left(\frac{R}{R + R'}\right)$
Streamside	15	12	55
Rock Cliff	3	3	50
Sagebrush	6	12	33
Rock Slide	2	5	28
Forest	3	10	23
Alpine vegetation	1	6	14
Average index of restriction—33.			

Likewise, the relative degree of restriction of the belt faunae may be expressed and illustrated in the same way:

<i>Vegetation belt</i>	<i>Restricted species (R)</i>	<i>Wide ranging species (R')</i>	<i>Index of restriction</i> $\left(\frac{R}{R + R'}\right)$
Sagebrush	13	19	40
Alpine	1	9	10
Spruce-fir	1	22	4
Pine	1	27	3
Average index of restriction—14.			

If the Spruce-Fir and Pine Belts are considered together as the Coniferous Forest, the situation is but slightly altered, for 5 species are restricted to the forest and 23 are wide-ranging, yielding an index of restriction of 17. This increases the average to but 22. If, however, the total faunae of the three upper belts are considered as belonging to the Mountain Slope Zone and compared with the fauna of the Sagebrush Belt or Plains Zone, a faunal zonation is revealed as follows:

<i>Zone</i>	<i>Restricted species (R)</i>	<i>Wide ranging species (R')</i>	<i>Index of restriction</i> $\left(\frac{R}{R + R'}\right)$
Plains	13	21	38
Mountain Slope	10	21	32
Average index of restriction—35.			

The average indices of relative restriction for the communities and zonal faunae are about two and one-half times as great as that for the belt faunae. Hence, comparing the relative degrees of restriction of the three groupings, it is evident that the communities and the zonal faunae show more evidence of mammal restriction in this region than the belt faunae. The fact that a zonal fauna includes a number of communities which in themselves are relatively restricted in composition, points to the conclusion that the community in this case is the most applicable grouping in classifying the mammal distributions.

Similar tests as these may very well be applied in the field in order to determine graphically the relative values of different groupings or schemes of classifying distributions, each of which is based upon some conspicuous factor in the environment.

Nichols (1930), in reviewing the present day tendencies of European plant ecologists, notes that the Swiss-French school advocates a test which they apply to the plant community and which they designate by the term

"Exclusiveness." By this is meant the degree in which a species is restricted to one particular community to the exclusion of others. This is somewhat comparable to the degree of restriction described in this paper, although it does not necessarily involve an index. The Swedish school, however, does not consider the test of "Exclusiveness" of any ecological significance.

Allen (1878) in a like manner compared the numbers of indigenous genera and families with the number of cosmopolitan ones in classifying zoogeographical realms, regions and provinces.

The purpose of the index of restriction as described is to compare the different schemes or groupings of classification of mammal distribution. Each scheme should be based upon some outstanding factor in the environment such as topography, temperature, humidity or vegetation in order that the applicability or significance of these factors may be determined. Hence, much depends upon the sane judgment of the individual in picking out the conspicuous factors in the environment upon which to base his schemes. The greater the number of schemes used, the less chance there is of missing an important factor in that region. For instance, if the distributions of the mammals of a region should be classified according to ten different schemes based upon ten different factors in the environment and three of these should be found to have equally high average indices of restriction, then it would be legitimate to conclude that of all the factors considered, these three were relatively the most significant in determining the distributions in that region. There seems no reason why this index of restriction may not be applied to any group of animals, the distributions of which can be classified according to different schemes based upon different predominating factors in the environment.

DIFFERENT CLASSIFICATIONS OF THE VEGETATION BELTS

Although the vegetation belts do not show any great degree of mammal restriction in the Uinta Region they are very conspicuous. Table II compares the classification of the vegetation belts adopted by the writer for the northern slope of the Uinta Mountains with similar classifications for the states of Utah and Nevada (Tidestrom, Shantz, and Sampson in Tidestrom, 1925; Cottam, 1929; and Nord, 1929). No two authors agree exactly. Tidestrom, Shantz, and Sampson all deal with Utah and Nevada and yet disagree in minor respects. Cottam deals with Utah only and agrees in different details with these three authors. Nord, in conjunction with the United States Forest Service, has compiled a classification based more particularly, I judge, upon the southern slope of the Uinta Mountains. He distinguishes two separate pine belts where I have but one and gives the juniper-pinyon belt equal ranking with the other belts. In general these classifications are comparable and where they are not, the name of the belt so indicates. Such a system is flex-

ible and extremely useful in comparing regions and showing the altitudinal zonation of plants.

CONSIDERATION OF CERTAIN CONCEPTS

THE MAMMAL COMMUNITY AND HABITAT

In this study the term association has been avoided as much as possible owing to the fact that it has recently come to have almost as many meanings as the number of persons using it (Clements, 1916; Gleason, 1926; Nichols, 1929). The more noncommittal terms, habitat and community, are used in its place. Even these terms have come to connote different meanings to different people. It will be necessary, therefore, to state the sense in which these terms are used here. The term habitat is used as meaning a definite type of area characterized by easily recognizable and relatively constant features. For instance, the rock slides constitute one habitat, or, as some may prefer to call it, a habitat-type, in counter-distinction to what is sometimes called a unit habitat. The communities which inhabit these habitat-types are likewise type communities inasmuch as certain characteristic forms are always found in these habitats although other forms may be added to or subtracted from the habitats as they are repeated or duplicated. The community-type is, therefore, relatively constant in regard to its habitat-type. It will be understood, then, that as the terms are used here, the mammal communities and habitats are referred to in the sense of type communities and type habitats.

As the habitat is repeated in different vegetation belts and so at different altitudes, the community which it shelters may become modified and so differ in composition—additional species may occur or some may drop out. Often a mixed habitat results in an intermediate region. For instance, where the trapping station was maintained on Sheep Creek (Fig. II), the altitude and surrounding vegetation indicated the Sagebrush Belt. However, constituents of both sagebrush and upper belt fauna and flora (see p. 56) were found there. The community, then, is modifiable but must have some degree of habitat restriction to be retained as such in the present classification.

COMPARISON WITH THE PLANT ASSOCIATION

Inasmuch as the community is considered here as occupying a definite habitat which becomes a workable unit in classifying distributions, it may be compared with the recently much disputed concept of the plant association. Gleason's (1926, p. 23) idea is that of a concrete association which is brought about as "the resultant of two factors, the fluctuating and fortuitous immigration of plants and an equally fluctuating and variable environment." Hence, it is not analogous to an organism nor can it be considered a unit of vegetation. Clement's viewpoint (1916, pp. 124-129) involves the inevitable attain-

ment of a climax—the result of progressive successions—which is comparable to an organism in that it is subjected to the same developmental laws. His term association is restricted to the climax communities which make up the formation. Nichols (1929, p. 637) takes the very sane viewpoint of regarding the plant association as “a piece of vegetation which exhibits essential uniformity in floristic composition and ecological structure.” It may be regarded in either an abstract or concrete sense but it is primarily a definite “fundamental unit of ecological plant sociology.” He compares it with the species concept which varies notoriously in the opinions of different systematists. However, as he pertinently remarks (p. 631) “is absence of general agreement . . . any more reason for discarding our concept of the species as a floristic unit?” The mammal community, as it is used and defined here as a distributional unit, agrees closely with Nichols’ view of the association. However, in regard to the causes which bring it about, Gleason’s idea of the plant association depending upon the coincidence of immigration and the environment for its existence resembles, in my opinion, my idea in regard to the factors responsible for the composition of the mammal community. The mammal community at any one time is the result of a complex of interacting factors which are constantly producing changes and of which one or several may be more in evidence at that time.

ZONAL INFLUENCE

Altitudinal zonation of the vegetation is conspicuous on the mountain slopes of the western United States. This is particularly true of the northern slope of the Uinta Mountains. The broad vegetation belts are prominent regardless of the fact that they interdigitate and overlap (Fig. II). There are also two broad topographic zones in this region, the Plains Zone and the Mountain Slope Zone, as well as various types of habitats. It has been shown (p. 62) that the zones and habitat-types have a greater degree of mammal restriction in this region than do the vegetation belts. It was also shown that the habitat-type is the logical grouping in classifying the mammal distributions in this region. This view may be substantiated by considering the repetition of the habitats in the different belts and zones. Where the habitat of a mammal community recurs in a different vegetation belt, characteristic members of the community also recur. Thus, a type of habitat is established. For instance, the Rock Slide Habitat-type appears in the Pine, Spruce-Fir and Alpine belts. The pika, marmot and two species of chipmunks are found in this habitat-type regardless of the belt. This illustrates the predominating influence of the habitat-type over the vegetation belt. It is only when the habitat is restricted to a definite belt that the community is also restricted, *i.e.* the Rock Cliff Habitat and Community; the Alpine Vegetation Habitat and Community. Likewise, the habitat-type is transcendent in influence over the topographic zone. The Stream-side Habitat-type occurs in both the Plains

and Mountain Slope Zones. Such characteristic members of this habitat-type as the beaver, muskrat, mink, meadow mouse and shrew also recur. The Sagebrush Habitat-type appears in both zones. The deer mouse, badger and jack rabbit are similarly associated with it regardless of zone.

Field naturalists who use the life-zone system of classifying animals and plants usually find that the plants fit into this classification fairly well, chiefly on account of the fact that the life zones are based in part upon the plant indicators. However, they experience far more difficulty in forcing the mammals and other vertebrates into such a scheme. Many authors, although describing animal distribution as based primarily upon life zones, have used habitats or associations for a more adequate determination of the vertebrate distributions.

Grinnell and Storer (1924, p. 9) state, "Frankly we found difficulty in assigning some parts of the Mono portion of the Yosemite section to one life zone rather than to another." Again (p. 11), "the limitation of species on the life-zone concept is not the only sort of segregation which occurs . . . often a far more conspicuous manner of delimitation is manifest, the delimitation which takes place on the basis of 'associations.' . . . Not rarely, associational restriction seems to be transcendent over zonal restriction."

Taylor (1922, p. 216) says, "A combination of the life zone, mapped on broad lines with temperature as the basic factor, and the habitat with its association, determined chiefly on water relations, should afford a more adequate picture of the distribution of plant and animal life on Mount Rainier than would either alone."

Cary (1911 and 1917), in applying life zones to the fauna and flora of Colorado and Wyoming, does not list any convincing number of animals, of mammals at least, which could be used in determining the upper life zones. All of the life zones recognized by him show a high degree of overlapping, especially in respect to the mammal fauna. Howell's life-zone classification of Alabama (1921) has been criticized by Dice (1923) as another illustration of forcing nature into pigeon-holes. The indefiniteness of life zones is often the rule rather than the exception in the field. Dice (1916), Grinnell and Storer (1924), Grinnell (1914), Taylor (1922), Allee (1926), and others have all encountered it.

In the Uinta region, Merriam's life zones cannot be applied, for temperature data are lacking or incomplete and the plants which are supposed to characterize the different life zones are not always in their proper places. Cottam (1930), speaking of the flora of the Uinta Mountains, says, "Some of the best examples of zone jumbling to be found in Utah are furnished by this region, . . ." Even granting that in regard to the plant life alone, the vegetation belts as described here may be considered as approximating life zones, certain difficulties are confronted. For instance, Cary (1917) includes lodgepole pine in the Canadian zone whereas in the Uinta region this pine and

the yellow pine present a distinctly mixed forest. Hence, the pine belt could be called "transition" because of the yellow pine or "canadian" because of the lodgepole pine. In regard to the mammal distribution of this region, life zones cannot be applied, for, it has been shown that the mammals here are restricted in their distributions primarily by their habitat relationships and without regard to plant zonation.

SUMMARY

1. Field data concerning the ecological distribution of the mammals on the north slope of the Uinta Mountains were secured and classified according to three schemes, namely, topographic zones, vegetation belts, and habitat-types.

2. A test for the relative values of these three schemes involving an index of restriction and consisting of the ratio of restricted to ranging forms, is described and applied to the data secured in this region.

3. By means of this test, it is found that the mammal habitat-types and the community-types indicate the greatest degree of restriction and so form the most logical grouping for classifying the mammal distributions.

4. The mammal community and habitat is used by the writer in the sense of a type community and habitat and as such may be considered comparable to the plant association as determined by Nichols (1929, 1930).

5. The life-zone system of classifying distributions is found to be inapplicable to the mammals, at least in the Uinta region.

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TABLE I. *Climatological Data for Manila, Utah.*

7 YEARS	Temperature °F.												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Mean	17.7	23.2	31.8	39.9	47.5	57.9	65.4	63.2	54.4	50.0	32.0	18.2	41.8
Mean maximum.....	33.1	37.6	46.2	53.9	62.5	74.5	82.9	81.7	71.6	60.7	47.8	32.6	57.1
Mean minimum.....	2.3	8.7	17.3	25.8	32.5	42.0	47.9	14.8	37.1	29.2	16.2	3.8	25.6
9 YEARS													
Highest.....	62.0	59.0	68.0	77.0	86.0	95.0	89.0	95.0	88.0	82.0	73.0	64.0	95.0
Lowest.....	-32.0	-31.0	-14.0	-6.0	15.0	25.0	30.0	33.0	19.0	-3.0	-20.0	-28.0	-32.0
Precipitation, inches													
10 YEARS													
Mean.....	0.37	0.53	0.48	1.65	1.15	0.73	1.04	.065	1.10	1.46	0.50	0.43	10.09
Mean maximum.....	1.00	1.15	1.17	2.95	3.62	2.00	1.94	1.24	2.95	2.24	1.02	1.01	12.59
Mean minimum.....	T	T	0.11	0.39	0.28	0.15	0.55	0.13	0.14	0.22	0.03	0.05	7.10
8 YEARS													
Snowfall.....	5.00	7.20	4.30	8.10	1.80	0	0	0	0.40	1.90	4.00	7.40	40.10

(T means trace)

Frost Data.

8 YEARS

Average date of last killing frost in spring June 22
Average date of first killing frost in autumn..... Sept. 8
Average length of frostless season..... 78 days (127 days for Vernal)

10 YEARS

Longest frostless season.....106 days
Shortest frostless season..... 59 days

TABLE II. *Classifications of Vegetation Belts.*

Svihla	Nord	Cottam	Tidestrom	Shantz	Sampson
Alpine 11,700-11,900 meadow krumholz	Alpine	Alpine Grassland 10,000 and above	Alpine	Alpine Grassland	Arctic-alpine
		Spruce-fir 8,000-10,000	Subalpine		
Spruce-fir 10,500-11,700	Spruce-fir	Aspen	Spruce	Spruce-fir Forest	Spruce-fir Aspen-fir
		Spruce-fir 7,000-8,500	Aspen		
Pine 8,000-10,500	Aspen-lodge- pole pine	Western yellow 5,500-8,000 pine	Yellow pine	Western yellow pine	Yellow pine and oak brush
	Western yellow pine	Scrub oak 5,000-7,500			
(Cedar-pinyon minor belt 7,000-8,000)	Juniper- pinyon	Pygmy forest 4,000-7,000	Pinyon	Pinyon- juniper woodland	Pinyon- juniper
Sagebrush 5,800-9,000		Northern desert shrub 3,500-5,000	Sagebrush	Northern desert shrub	
		Salt desert shrub 1,800-3,500		Salt desert shrub	
		Southern desert shrub 1,800-3,500	Creosote bush	Southern desert shrub	

TABLE III. *Animals in Zones, +, restricted to habitat-type; —, specimens, signs or observations; (), reports or general knowledge.*

Topographic Zones Species in Plains Zone only	Vegetable Belts											
	Sagebrush			Pine				Spruce-fir			Alpine	
	Streamside	Rock Cliff	Sagebrush	Streamside	Sagebrush	Rock Slide	Forest	Streamside	Rock Slide	Forest	Alpine	Rock Slide
<i>Lutra c. canadensis</i>	(+)											
<i>Spilogale</i> sp.....	(+)											
<i>Mephitis hudsonica</i>	+											
<i>Citellus armatus</i>	+											
<i>Sylvilagus nuttalli grangeri</i>	+											
<i>Eutamias m. minimus</i>	+											
<i>Eutamias dorsalis utahensis</i>		+										
<i>Peromyscus crinitus auripectus</i>		+										
<i>Peromyscus boylei rowleyi</i>		+										
<i>Cynomys l. leucurus</i>			+									
<i>Perognathus parvus clarus</i>			+									
<i>Dipodomys</i> sp.....			+									
<i>Antilocapra a. americanus</i>			(+)									
Species common to Plains and Mt. Slope Zones												
<i>Thomomys pygmaeus</i>	+			+								
<i>Sorex palustris navigator</i>	+			+								
<i>Mustela vison energumenos</i>	+			+				+				
<i>Castor canadensis frondator</i>	+			+				+				
<i>Microtus n. nanus</i>	+											
<i>Microtus m. mordax</i>	+			+				(+)				
<i>Ondatra zibethica osoyoosensis</i>	+			+				+				
<i>Taxidea t. taxus</i>			+			+						
<i>Lepus t. townsendii</i>			+			(+)						
<i>Sciurus f. fremonti</i>												
<i>Erethizon e. epixanthum</i>							+			+		
<i>Callospermophilus l. lateralis</i>							+			+		
<i>Peromyscus maniculatus osgoodi</i>	—	—		—	—	—	—					
<i>Lynx uinta</i>	—	—	—	—	—	—	—					
<i>Canis l. lestes</i>	()		—	—	()	—	()	()		()		
<i>Eutamias minimus consobrinus</i>	—		—	—	—	—	—	—		—	—	
<i>Eutamias umbrinus</i>	—		—	—	—	—	—	()	()		—	—
<i>Odocoileus h. hemionus</i>	—		—	—	—	—	—	—	()		—	—
<i>Felis oregonensis hippolestes</i>	—		()	—	—	—	—	—		—	—	
<i>Neotoma cinerea orolestes</i>			()	()	()	—	()	()	()	()		
(Bison b. bison) formerly ranging throughout this region.												
Species in Mt. Slope Zone only												
<i>Zapus p. princeps</i>				+								
<i>Marmota flaviventris nosophora</i>						+			(+)			+
<i>Ochotona princeps uinta</i>						+			+			+
<i>Glaucomys sabrinus bangsi</i>							+			+		
<i>Clethrionomys gapperi galei</i>								+				
<i>Thomomys</i> sp.....											+	
<i>Euarctos a. americanus</i>				—	—		()	()		()		
<i>Ursus horribilis</i>				()	()		()	()		()		
<i>Lepus b. bairdi</i>					—		()			—	—	
<i>Cervus c. canadensis</i>				()	—		—	()		—	—	



FIG. 1. Map of northeastern Utah and parts of Wyoming and Colorado showing location of Wasatch and Uinta Mountains (after Atwood, 1909).

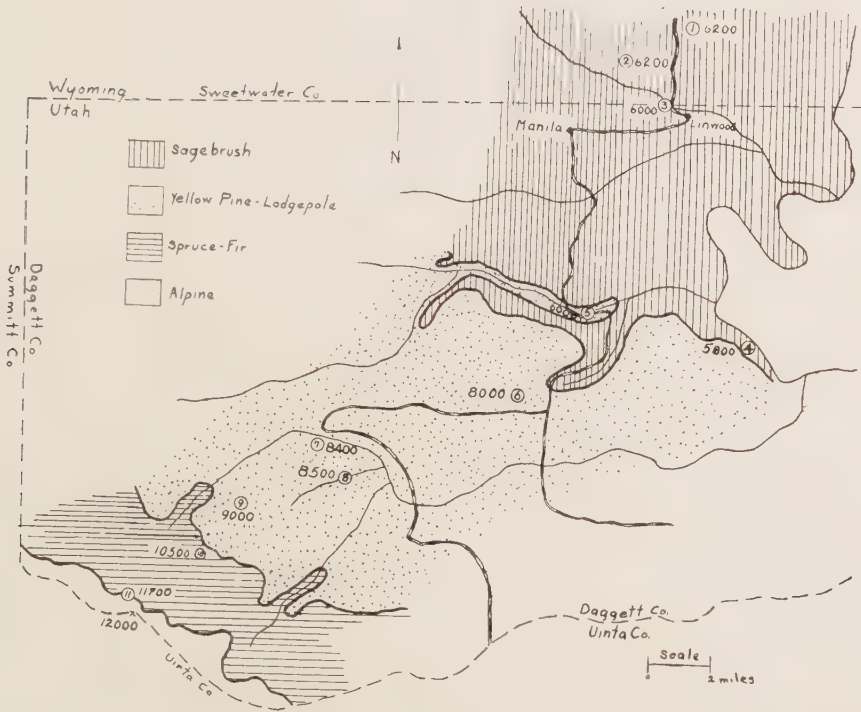


FIG. 2. Detail map of Daggett County, Utah and Sweetwater County, Wyoming, showing dominant vegetation belts, important creeks and rivers, and the following collecting stations with their respective altitudes: (1) Two miles north of Linwood, Utah; sagebrush plains. (2) One mile north of Linwood, Utah; rock cliff habitat and petroglyph rocks. (3) Henry's Fork; streamside habitat, sagebrush belt. (4) Hide Out; streamside habitat, sagebrush belt. (5) Sheep Creek; mixed habitat, sagebrush belt. (6) West of Summit Springs; mountain park, pine belt. (7, 8) Beaver Creek; mountain park, pine belt. (9) Granite Park; mountain park, pine belt, approximate upper limit of sagebrush and deer mouse. (10) Beaver Dams; streamside habitat, spruce-fir belt. (11) Timberline on the Nipple; alpine belt.

*TRANSECT of NORTH SLOPE of UINTA MTS.
Showing Dominant Vegetation Belts and
Topographic Zones*

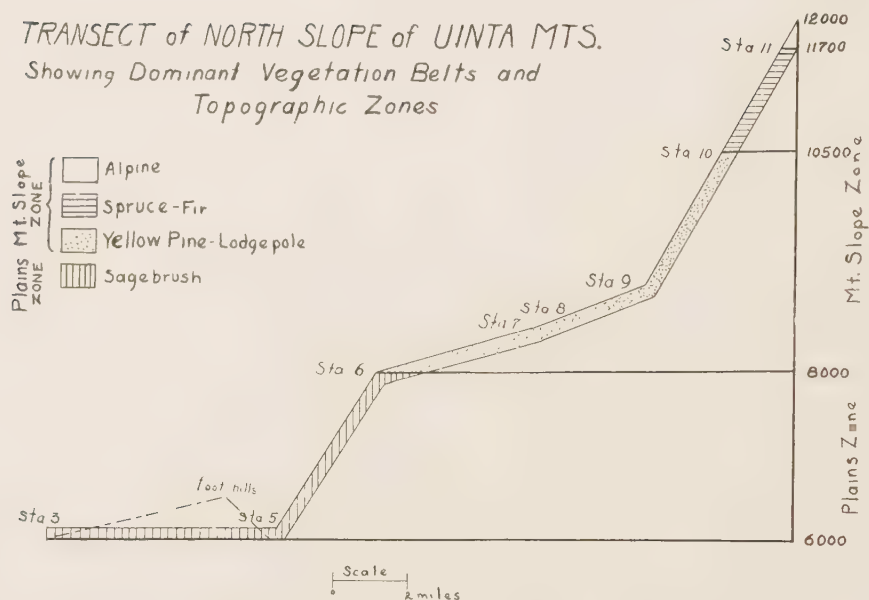


FIG. 3. Ideal transect of the north slope of the Uinta Mountains, Utah, showing profile of the mountain slope, vegetation belts, topographic zones, collecting stations and altitudes.



FIG. 4. Sagebrush Habitat of the Sagebrush Vegetation Belt, 2 miles north of Linwood, Utah, (6200 feet), Station 1 (Fig. 2). Typical habitat of such mammals as the prairie dog, pocket mouse, deer mouse, coyote, jack rabbit and, formerly, the antelope.



FIG. 5. Prairie dog in a prairie dog town on a flood plain of Green River, near the mouth of Henry's Fork.



FIG. 6. Collecting Station 5 (Fig. 2) on Sheep Creek, 6000 feet altitude, showing character of the canyon, a mixed habitat where upper belt flora and fauna mingle with lower belt forms. Cedars dot the canyon slopes.



FIG. 7. Talus slope of Rock Cliff Habitat on Sheep Creek canyon showing steepness of the slope. Cedars and sagebrush have become established here. This is the habitat of the golden-breasted canyon mouse.



FIG. 8. Upper Sheep Creek canyon showing Douglas firs which extend down into the Sagebrush Belt along such cool canyons.



FIG. 9. Sagebrush in a mountain park in the Pine Belt, 8500 feet altitude. Station 8 (Fig. 2), showing dense lodgepole-pine forest in the background and sagebrush in the foreground.



FIG. 10. Mountain park at Beaver Creek (8500 feet) looking towards the Nipple, which is the peak at the right; grassy flood plain subhabitat of the pocket gopher in the foreground, which is sharply marked off from the sagebrush. Lodgepole and yellow-pine forest in the background.



FIG. 11. Beaver house on Beaver Creek near Collecting Station 8 (Fig. 2). Muskrats had built a house on the right hand side of this.



FIG. 12. Elk Park in the Pine Belt at 8000 feet altitude, showing willow subhabitat of the jumping mouse.



FIG. 13. Elk Park showing open growth of western yellow pine.



FIG. 14. Hoary marmot, *Marmota flaviventris nosophora*, in a rock slide of the Pine Belt.



FIG. 15. Creek at Beaver Dams, Station 10 (Fig. 2), at 10500 feet altitude in the Spruce-Fir forest. The Nipple is the peak in the distance.



FIG. 16. Timberline (11700 feet) on the Nipple, looking back on the Spruce-Fir forest.



FIG. 17. Pika or coney, *Ochotona princeps uinta*, on a rock slide above timberline on the Nipple.

